

# Enhancing the electro-mechanical properties of polydimethylsiloxane elastomers through blending with poly(dimethylsiloxane-co-methylphenylsiloxane) copolymers

**Yu, Liyun; Jeppe Madsen, Peter; Boucher, Sarah ; Skov, Anne Ladegaard**

*Publication date:*
2018

*Document Version*
Publisher's PDF, also known as Version of record

EuroEAP 2018
International conference on Electromechanically Active Polymer (EAP) transducers & artificial muscles
Valpré Ecully - Lyon, France, 5-6 June 2018
Organized and supported by 'European Scientific Network for Artificial Muscles – ESNAM' (www.esnam.eu) COST Action MP1003

# Enhancing the electro-mechanical properties of polydimethylsiloxane elastomers through blending with poly(dimethylsiloxane-co-methylphenylsiloxane) copolymers

Liyun Yu, Peter Jeppe Madsen, Sarah Boucher, Anne Ladegaard Skov*

The Danish Polymer Centre, Department of Chemical and Biochemical Engineering, Technical University of Denmark, 2800 Kgs. Lyngby, Denmark

* Corresponding author: Tel.: +45 45252825; Fax: +45 45882258. E-mail: al@kt.dtu.dk

Dielectric elastomers (DEs) hold great promise as materials for novel, advanced electromechanical applications such as actuators, generators and sensors. [1] Choosing the right polymer for the blending approach is of utmost importance to improve the electro-mechanical properties of DEs. [2] A study in our laboratories shows that sub-percentage additions of various aromatic substances can increase electrical breakdown strength significantly via voltage stabilisation, due to an electron trapping effect. [3-5]

In this work, improved electro-mechanical properties of silicone-based dielectric elastomers are achieved by means of adding so-called "voltage-stabilisers" prepared from phenyl-functional copolymers prepared using oxyanionic ring-opening polymerisation of octamethylcyclotetrasiloxane (D4) and either tetramethyltetraphenylcyclotetrasiloxane (T4) or octaphenylcyclotetrasiloxane (O4). The concentration of the voltage stabiliser was varied both by changing the molar ratio between methyl and phenyl groups in the copolymer and also by varying the amount of copolymer mixed into a polydimethylsiloxane (PDMS)-based elastomer. The phenyl-functional copolymers were generally found to disperse homogeneously in the PDMS matrix and this resulted in networks with improved mechanical and electrical properties. The developed elastomers were inherently extensible with enhanced tensile and tear strengths, due to phenyl-rich microphases acting as reinforcing domains. Furthermore, addition of phenyl-functional copolymers resulted in elastomers with increased relative permittivity and electrical breakdown strength compared to control elastomers while retaining a low dielectric loss. This demonstrates their efficiency as voltage stabilisers.

**Keywords**: electro-mechanical properties, silicone dielectric elastomer, voltage stabiliser, phenyl functionalised copolymer, blend

## References

1. F. B. Madsen, A. E. Daugaard, S. Hvilsted and A. L. Skov, *Macromol. Rapid Commun.*, 2016, **37**, 378.
2. A. L. Skov and L. Yu, *Adv. Eng. Mater.*, DOI: 10.1002/adem.201700762.
3. A. H. A Razak, P. Szabo and A. L. Skov, *RSC Adv.*, 2015, **5**, 53054.
4. A. H. A Razak and A. L. Skov, *RSC Adv.*, 2017, **7**, 468.
5. A. H. A Razak, L. Yu and A. L. Skov, *RSC Adv.*, 2017, **7**, 17848.